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2017 SUCCESS STORIES



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U.S. AIR FORCE

SBIR/STTR PROGRAM DIRECTOR



An unrivaled strategic allocation of resources is key to holding the advantage over our adversaries. Few examples of technology spending across the federal government have the potential to make a bigger impact on that goal than the Air Force Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Program.

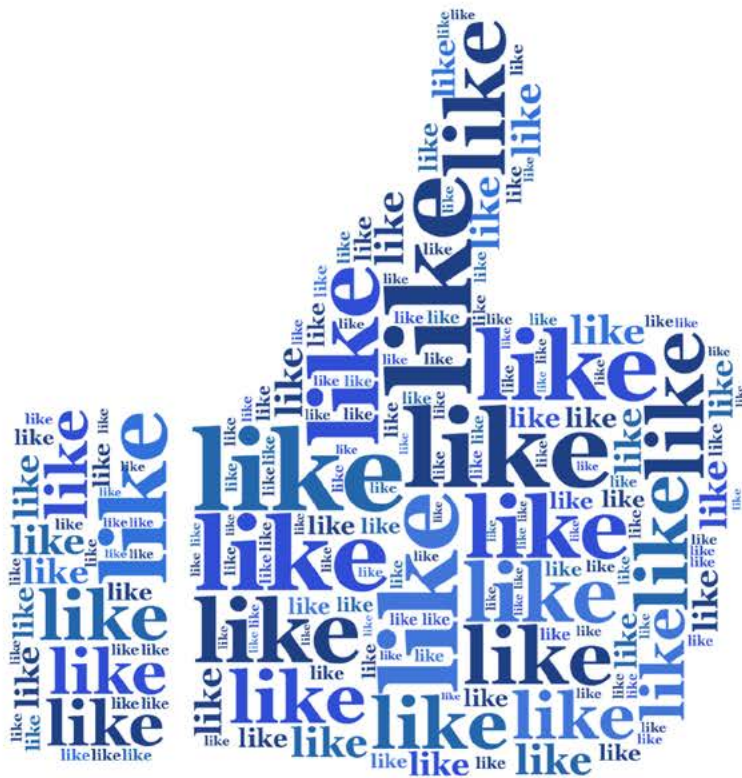
By addressing what is known as the “Three R’s” – Responsive, Relevant and Revolutionary – the Air Force and its small businesses partners strive for advancements that support major commands and meet near-term critical needs while filling the pipeline with potential game-changing technologies. In stressing innovation over invention, we work to drive down costs, get the best new technology to the warfighter and boost the economy through small business growth.

Success by companies participating in the Air Force SBIR/STTR Program can be measured in a variety of ways. As topics move through the lifecycle of scientific development – from the concept stage to use in the field, and ultimately to commercialization – each advancement has value that we should celebrate.

It would be impossible to show every success, because the total program portfolio is vast, so we put together this book to illustrate some of the most notable stories from the past year. These examples are among the best of the best. Please join me in celebrating the Air Force SBIR/STTR Program and the value it brings to taxpayers by strengthening national security as well as the economy.

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Trident Systems Inc.
SAN PEDRO, CALIFORNIA

NEW CAPABILITY BRIDGES COMMUNICATION GAP ACROSS DIFFERENT SECURE NETWORKS

The U.S. and its coalition partners work closely together in the field, but those efforts are typically hindered by an inability to communicate across separately classified networks.

That problem, however, may soon be a thing of the past.

With support from the Air Force SBIR/STTR Program and Air Force Research Laboratory's Rome Research Site, Virginia-based Trident Systems Inc. deployed a certified cross-domain voice and video capability in the field. The technology – known as V2CDS – is being touted as a first-of-its-kind, real-time voice and video bridge between different secure networks.

V2CDS has been tested by the National Security Agency and certified for deployment at the "Secret and Below Interoperability" level by the Defense Information Systems Agency. The technology was recently installed at an overseas command to connect separate security domains and is now available on the GSA schedule as a commercial product.

BEHIND THE TECHNOLOGY

The heart of V2CDS lies in Trident Systems' software, which is designed to work with commercial off-the-shelf Voice over Internet Protocol hardware. Most organizations today already have VoIP hardware for their phone systems.

Cross-domain calls can be established as easily as making a long-distance call. A user simply enters a pre-configured prefix number to initiate the call, which is forwarded to V2CDS for processing. The system then prompts the user for authentication and the remote number to dial. A similar authentication process is done on the receiving end.

V2CDS users can make two-party direct and multi-party conference calls, allowing people across two secured networks to communicate simultaneously. In addition, V2CDS enables users to conduct cross-domain, point-to-point videophone calls.

*Strikes a balance between protecting
and sharing critical information*

EQUIPPING THE **WARFIGHTER**

Trident workers test the V2CDS system, which is being touted as a first-of-its-kind, real-time voice and video bridge between different secure networks.
(Courtesy photo)



The video solution authenticates users and reduces covert channels to an acceptable risk level, while simultaneously maintaining useful, point-to-point capabilities.

A REAL NEED

The balance between protecting and sharing critical information has never been more important than in today's joint and coalition military environment.

VoIP and point-to-point video are common tools for sharing information throughout joint operations involving the Department of Defense and intelligence community. However, the proliferation of secure network enclaves has created communities of users who frequently are unable to collaborate with each other across their network boundaries.

Working with coalition partners adds another wrinkle. In lieu of electronic communications, combatant commands must temporally open classified areas to non-U.S. citizens for personal meetings. That presents a security risk as well as an additional expense.

With V2CDS, regular meetings with coalition partners or among joint forces can take place without disruptions to normal operations. A standing cross-domain conference call is arranged and participants may call in from their normal VoIP phone, without having to leave their office, to join the meeting.

A LONG-TIME PARTNERSHIP

Trident Systems has worked on cross-domain technologies for many years with AFRL, initially implementing a secure text chat capability that works with existing cross-domain solutions. Company leaders and AFRL recognized a need for cross-domain voice and video capabilities, as there were no systems to address this gap, and Trident Systems invested in its "assured pipeline" concept to filter media traffic.

The approach proved successful. SBIR funding – as well as support from the Air Force SBIR/STTR Commercialization Readiness Program and AFRL – was used to bridge the gap between development and transition to the field. That included the implementation of required security controls for government certification as well as extensive testing and deployment.

The V2CDS project represents validation of the early investment Trident Systems has made into the assured pipeline technology. Additionally, it enabled the company to establish a new product line that benefits the Department of Defense and intelligence community.

"V2CDS is the first of a new generation of affordable, secure, cross-domain voice and video communication capabilities and has become our flagship collaboration product supporting the warfighter," said Nick Karangelen, president of Trident Systems.

ES3

CLEARFIELD, UTAH

IMPROVED AIRCRAFT LANDING GEAR PROTECTION TAKES TO THE SKIES

Spawned by a small business collaboration, the Air Force and aerospace industry now have a more environmentally-friendly and lower-cost option to protect a key aircraft system.

With support from the Air Force SBIR/STTR Program, Utah-based ES3 developed a process for plating steel aircraft landing gear components with Low Hydrogen Embrittlement Zinc-Nickel. Along the way, ES3 worked closely with a unit of prime contractor Boeing, as well as coating manufacturer Dipsol of America, to make the technology a reality.

Low Embrittling Cadmium has traditionally been used as a sacrificial protective coating on high-strength steel aircraft landing gear to prevent corrosion, but is highly toxic so it poses a danger to the environment as well as to those workers who would handle it.

Also known as LHE (Low Hydrogen Embrittlement) Zinc-Nickel, the alternative chemical is much safer, has shown to provide better protection and costs less when environmental factors are taken into account. LHE Zinc-Nickel has been used for other lesser-strength steel applications, such as auto manufacturing, but not successfully applied to high-strength steel aircraft landing gear until now.

“Cadmium has been an aerospace corrosion protection plating for years and years,” said Dave Frederick, a lead engineer for the Landing Gear Systems Division of the 417th Supply Chain Management Squadron at Hill Air Force Base in Utah. “This development has been significant and will be relevant for a long time down the road.”

An LHE Zinc-Nickel plating line has been installed at Hill Air Force Base, where the 309th Commodities Maintenance Group is using the new method to overhaul an increasing number of landing gear components. Frederick said early financial assessments projected the new line would yield a multi-million dollar savings on hazardous waste disposal.

In addition to addressing legacy systems – a big step because it requires changes to drawings and specifications – LHE Zinc-Nickel also has the potential to be widely adopted for new aircraft manufacturing. Frederick said the specifications are available to any vendor that wants to set up a line, and an increasing number of new part acquisitions identify LHE Zinc-Nickel as a “preferred” plating method.

EQUIPPING THE **WARFIGHTER**

Sebastian Harrelson, an electroplater in the 309th Commodities Maintenance Group, prepares to submerge the nose gear of an F-16 at Hill Air Force Base, Utah. The 309th CMXG is overhauling an increasing number of landing gear components with a more eco-friendly coating developed under the Air Force SBIR/STTR Program.
(U.S. Air Force photo by Alex R. Lloyd)



COLLABORATION WAS KEY

Aircraft manufacturers and overhaul facilities have been able to obtain a waiver to use cadmium on landing gear systems because there has been no feasible corrosion coating substitute. In recent decades, the industry has been trying to develop an environmentally-friendly, cost-effective, drop-in replacement.

Boeing endeavored to find a solution – through extensive laboratory testing of Dipsol’s LHE Zinc-Nickel coating – but was never able to scale-up the plating application process. When the Air Force decided to pursue a similar avenue using the SBIR program, ES3 answered the call

“LHE Zinc-Nickel has been the first coating developed that meets all the technical requirements of a protective sacrificial coating and ES3 elevated it to the next level, which is what the Air Force and aerospace industry needed,” said Steve Gaydos, a technical fellow for Boeing Research and Technology.

“Basically what they were doing is creating a (LHE) Zinc-Nickel (application) process that could be used in a large aerospace company, like Boeing, or by the Air Force. It was a fantastic partnership. All that knowledge was built upon the SBIR program.”

Air Force SBIR/STTR funding allowed ES3 to advance the technology through extensive qualification testing, which included adhesion, corrosion, fatigue, hydrogen embrittlement, re-embrittlement and brush plating.

The Air Force SBIR/STTR Commercialization Readiness Program, along with the Department of Defense Environmental Security Technology Certification Program, provided support for the company to scale up testing from simple laboratory LHE Zinc-Nickel plating to full-scale landing gear plating at Hill Air Force Base.

“This advancement wouldn’t have happened without the SBIR program,” said Craig Passetto, lead materials and process engineer at ES3.

Revolutionary new process will save money and be less harmful to workers and the environment

and connected with Boeing, which provided a wealth of technical support and laboratory test data on Dipsol’s coating.

Luna Innovations Inc.
ROANOKE, VIRGINIA

NEW TECHNOLOGY EXPECTED TO PLAY PIVOTAL ROLE IN REDUCING AIRCRAFT CORROSION COSTS

The Air Force is taking aim at its multi-billion dollar aircraft corrosion challenges through a partnership with a Virginia-based small business.

Luna Innovations Inc., with support from the Air Force SBIR/STTR Program, developed technology that improves upon the laboratory evaluation of aerospace coatings and provides service-life estimates for coatings in actual environments. Having a better way to measure the effectiveness of coatings that protect aircraft structures from corrosion and environmentally-produced cracks will allow the Air Force to accelerate the adoption of new coatings while reducing the risk associated with their integration.

The Air Force Life Cycle Management Center recently selected Luna Innovations' corrosion and coating evaluation system – known as CorRES – as part of its efforts to measure the severity of aircraft service environments through base deployments. The system is expected to help the Air Force reduce its nearly \$6 billion annual cost of addressing aircraft corrosion.

“The CorRES system is well aligned with Air Force Life Cycle Management Center goals for improved corrosion management and sustainment practices,” said David Ellicks, a senior materials engineer at the Air Force Corrosion Prevention and Control Office. “CorRES is also being considered for use as part of the Air Force’s new accelerated corrosion test system at the Air Force Research Laboratory.

CURRENT TESTS OFTEN LACK CRITICAL DATA

Since corrosion-inhibiting primers are the first line of defense for maintaining aircraft structural integrity, ensuring new products match or exceed the performance of legacy products is paramount.

The problem is that conventional coating test methods are subjective measures of performance. Expert examination of coated panels are often presented in a pass/fail format. These tests focus on aesthetic performance and do not provide data of localized corrosion processes that represent the greatest risk to aircraft structures. As a result, they lack critical coating system characteristics needed for developers or users to select the best coating for a given application.

The uncertainty associated with conventional coating tests presents a risk for the introduction of new, safer and environmentally sound coatings for aerospace applications.

EQUIPPING THE **WARFIGHTER**

*A Luna Innovations employee installs a corrosion and coating evaluation system into an accelerated test chamber. The system was developed with support from the Air Force SBIR/STTR Program and the Air Force Commercialization Readiness Program.
(Courtesy photo)*



BEHIND THE NEW TECHNOLOGY

Luna Innovations' CorRES measures the ability of coatings to protect aircraft structures. It can be used for laboratory or outdoor coating testing and includes sensor panels that can be painted and tested like traditional materials. The sensor panels measure the ability of a coating to protect a substrate from the environment, or in the case of coating defects, the ability to inhibit corrosion.

Each system produced by the company includes continuous environmental measurements of temperature and humidity. A module for evaluating the ability of coatings to protect alloys from stress corrosion cracking and corrosion fatigue is also part of the system. Data collection and storage is fully automated so that environmental measurements, along with corrosion rate and crack velocity, are continuously measured throughout a test.

This Air Force SBIR/STTR Program – with additional support from the Air Force SBIR/STTR Commercialization Readiness Program – allowed Luna Innovations to advance the technology from a basic concept to a fully commercialized product.

It has since been used by the Air Force, the Navy, aircraft manufacturers and aerospace coating manufacturers. Additionally, the sensors that form the basis of the coating measurement system are aligned with the U.S. national standard for monitoring atmospheric corrosion and coating performance.

Allows the Air Force to reduce its nearly \$6 billion annual cost of corrosion

MMA Design LLC
BOULDER, COLORADO

POWER BOOST GIVES MISSION PLANNERS MORE FLEXIBILITY TO USE SMALLER, LOWER-COST SATELLITES

The Air Force will be able to use an emerging class of lower-cost satellites for more missions because of a better power source developed in partnership with a Colorado-based company.

With support from the Air Force SBIR/STTR Program, MMA Design LLC created a steerable solar array for CubeSats that incorporates processes typically used on larger, more complex and more expensive spacecraft. Also known as HaWK – which stands for High Watts per Kilogram, a performance metric – this new system allows groups of solar panels to be continuously adjusted toward the sun to capture the most energy possible.

The ability to achieve longer life and reliability while operating in more extreme environments is especially significant for the use of CubeSats, a relatively inexpensive, miniaturized satellite. The rise in CubeSats opens the door for massive amounts of research, testing and observation that wasn't feasible with traditional satellites.

Initially, the Air Force deployed the HaWK technology from MMA Design for several low-earth orbit missions. The system was also purchased by NASA for the MarCO mission to Mars, which will provide the ability to quickly transmit status information about the Insight spacecraft while it lands on the red planet. The NASA mission, scheduled to launch in May, 2018, will be the first time CubeSats have been flown in deep space.

"The HaWK arrays from MMA Design were the only option because of their high power density and ability to fit on the edge of a CubeSat when the project started," said John Baker, of NASA's Jet Propulsion Laboratory.

While other companies are now developing comparable products, MMA Design, with the support of the Air Force SBIR/STTR Program, led the way in this critical arena.

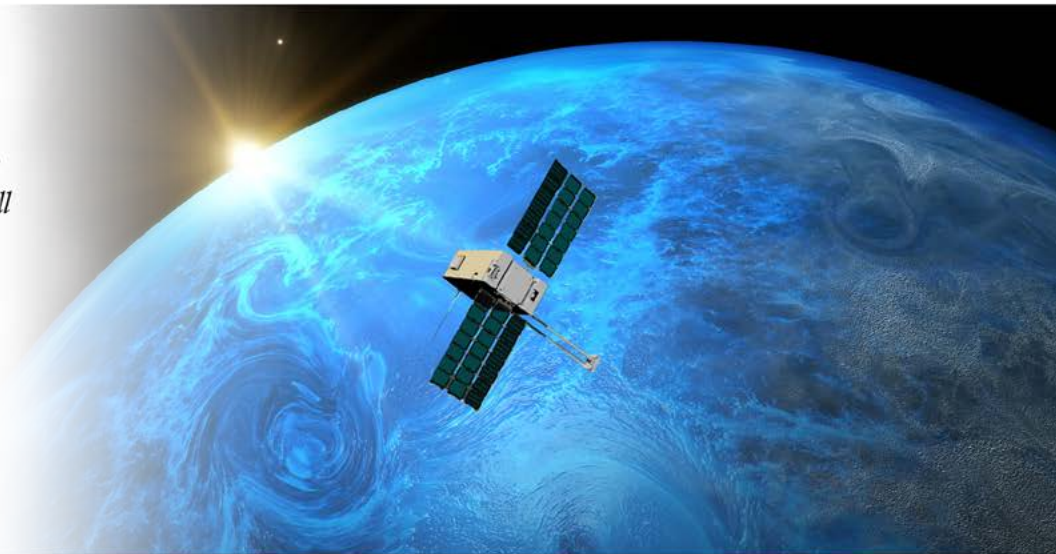
POWER NEEDS CREATE PROBLEMS

The Department of Defense has a growing demand for smaller satellites that can support higher performance missions. However, producing adequate power has been a challenge because of the inherent size constraints and static placement of solar arrays on those platforms. Using the largest solar arrays that fit on CubeSats would also reduce payload capacity and result in a disproportionate share of the spacecraft volume and mass being allocated to power generation instead of sensors, radios and other capabilities.

With CubeSats, the fundamental issue is having to pack everything into a clearly-defined and highly constrained volume, so existing solutions won't

EQUIPPING THE **WARFIGHTER**

A rendering of the steerable solar array created by MMA Design aboard a small satellite. The technology advancements were made possible with support from the Air Force SBIR/STTR Program. (Courtesy rendering)



Doubles the amount of power available to small satellites

scale down to address those challenges.

HaWK – a foldable semi-rigid panel solar array, in which the panels fold over each other in multiple configurations – is designed to double the amount of power in small satellites and increase peak power by 300 percent. It supports higher performance by allowing small satellites to maintain greater power reserves while freeing the mission instruments to track an area of interest and/or accomplish other objectives.

Low-profile hinges allow the solar array to stow in a very thin package. Also, the system can use any type of existing or future solar cell and stows in much smaller spaces than the newer roll-out solar arrays, which typically require a flexible solar cell to be able to form a tight enough radius as they collapse for stowage.

HaWK also comes into play at the end of a satellites' mission life, when it can be oriented to provide greater drag needed for deorbit. This will help federal agencies such as the Department of Defense to comply with the 25-year requirement to bring down satellites from orbit

and minimize the potential impact of debris.

SBIR FUNDING WAS CRITICAL

Funding from the Air Force SBIR/STTR Program supported MMA Design efforts to create flight-ready solar arrays. Throughout that time, the company grew from three people to more than 20 employees and continues to expand.

That type of growth is a result of successful commercialization, a critical target for companies involved in the Air Force SBIR/STTR Program.

"The SBIR funding has also enabled 12 missions to be launched by 2018 and significantly increased our military and commercial sales," said Mitchell Wiens, president and chief operating officer of MMA Design. "Our military and commercial sales have steadily increased and in 2017, our sales are projected to be three to four times that of 2015. This has also helped us to advance our technologies to larger, modular arrays for larger spacecraft requiring power up to 10 kilowatt, as well as spur technologies and innovation for our line of deployable antennas."

MMA Design is a recent winner of the U.S. Small Business Administration Tibbetts Award, which pays tribute to the best in SBIR achievements.

Kitware Inc.
CLIFTON PARK, NEW YORK

IMPROVED VIDEO PROCESSING CAPABILITY TO ENHANCE KEY INTERNATIONAL SUPPORT

The Air Force has a new way to share critical mission video footage that will bolster the confidence of allies while protecting classified information.

With support from the Air Force SBIR/STTR Program, New York-based Kitware Inc. created a tool for operational analysts to remove embedded, sensitive data from full-motion video before it is distributed to partner or host nations. Unlike traditional methods that cover sensitive material with black boxes, comparable to redacting information on paper documents, this new technology helps preserve the integrity of the video images.

Kitware's "burn-out" tool has been used in limited situations by Air Force Special Operations Command and is in the process of being accredited for more widespread use within that organization.

Originally, the company was working on a SBIR/STTR project with another federal agency to develop the core video processing technology for a different purpose. That's when officials from the Air Force Research Laboratory saw the potential for applying it to video intended for sharing.

ADDRESSING A UNIQUE NEED

Some situations at Air Force Special Operations Command warrant the providing of mission video to other countries. For example, the Taliban has been known to falsely claim that civilians were injured or killed during the capture of a high-value target. In those types of cases, providing partner and host nations with aerial video of the true sequence of events is beneficial to U.S. interests.

The problem is that embedded – sometimes referred to as "burned-in" – data in the original video contains classified information. Using the traditional method to sanitize the video, which produces large swaths of blacked-out areas, can give the appearance that relevant footage is being hidden. Kitware's burn-out tool can be used to create a high-quality version of the footage with the sensitive information removed.

"Air Force Special Operations Command needed the ability to distribute video in a more releasable format," said Juan Vasquez, a principal research electronics engineer with AFRL's Sensors Directorate during the development of the tool. "The burn-out tool is mitigating an operational artifact that doesn't exist in normal video."

EQUIPPING THE **WARFIGHTER**

With support from the Air Force SBIR/STTR Program, a New York-based company developed a tool to remove classified data from video before it is shared with partner or host nations. The tool is being used at Air Force Special Operations Command, which provides highly-trained forces for worldwide deployment. (U.S. Air Force photo/Staff Sgt. Melanie Holochwost)



BEHIND THE TECHNOLOGY

Kitware's burn-out tool is used to detect embedded data at the pixel level, then blend neighboring pixels from previous and future frames to intelligently cover it. The process overwrites data with new information, therefore the classified information cannot be retrieved after the footage is distributed.

"It looks better, and is more credible while still protecting the secure information," said Vasquez, who is currently working within AFRL's Airman Systems Directorate.

Originally, the technology was designed for a computer to perform all the work behind the scenes. Air Force SBIR/STTR funding enabled Kitware to develop the algorithm, make advancements in image processing techniques and modify the interface for its use directly by operational analysts at Air Force Special Operations Command.

ECONOMIC IMPACT

In addition to delivering a new technology, Kitware honed its expertise by working with Air Force analysts who specialize in video processing, exploitation and dissemination. The company is leveraging that experience to solve problems for other customers on different SBIR/STTR projects.

Kitware was also exposed to a new market for its open-source technologies, increasing the company's potential to grow revenue and add jobs. That's important because a key tenet of the Air Force SBIR/STTR Program is to boost the national economy through small business growth.

Protects classified information while preserving the integrity of images

NEW SOFTWARE TOOL EXPECTED TO BOOST INTELLIGENCE PRODUCTION CAPABILITIES

The Air Force Research Laboratory and an Ohio company are working to revolutionize the way critical information is processed by intelligence analysts who are increasingly overwhelmed by massive volumes of data while striving to ensure national security.

With support from the Air Force SBIR/STTR Program, Cincinnati-based Etegent Technologies Ltd. worked with AFRL's Airman Systems Directorate to create the NTellus Relationship Visualization tool. Also known as NTellusRV, the software allows analysts to more effectively examine and visualize information contained in large sets of location-based data. It also provides a new capability to discover and visualize relationships between different types of data sets so analysts can quickly discover relevant information in a way not previously possible.

Based on these advancements, Etegent Technologies earned a contract to transition the tool to the National Air and Space Intelligence Center. The company is working with analysts in NASIC's Advanced Technical Exploitation Flight to deploy NTellusRV within NASIC and is also exploring new analysis products that the tool could enable.

BEHIND THE TECHNOLOGY

NTellusRV converts different types of data into a common form, computes the correlations and other relationships, and presents high-interest details with corresponding locations. These 'intensity map visualizations,' which integrate and distill information into two-dimensional images, are well suited for big data. The more data that can be integrated, the better the resulting intelligence that can be discovered and displayed.

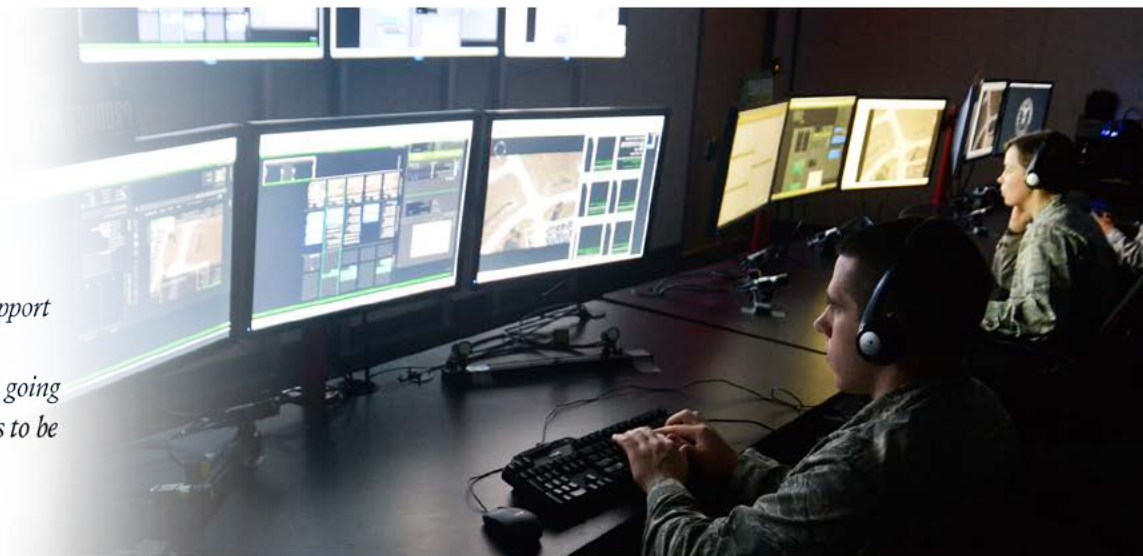
For example, an analyst producing assessments about people traveling to a specific area can readily collect open- source data through social media and other sources. By coordinating that anecdotal evidence with more traditional surveillance resources through NTellusRV, the analyst can more accurately estimate the origin of visitors, their risk profile and possible recent activity in order to provide better intelligence for assessing potential threats.

From a technical standpoint, the NTellusRV project developed or improved upon the following capabilities:

- Exploring relationships between different data sets across time and space;
- Creating visualizations that can be easily customized by analysts;

EQUIPPING THE **WARFIGHTER**

An Ohio-based business, with support from the Air Force SBIR/STTR Program, developed a tool that is going to be used by intelligence analysts to be more effective. (Air Force photo)



- Flexibly integrate with different databases;
- The ability to use and integrate different data types;
- Creating efficient database calls and integration;
- Optimizing data analysis calculations and visualizations execution speeds in order to efficiently handle massive data features; and
- Writing results to images or other common formats (e.g. KML/KMZ) so they can be used by a wide range of customers in the intelligence community.

Several key factors fueled the success of this Air Force SBIR/STTR project, according to Rik Warren, an analyst test bed technical advisor at AFRL. The first was identifying and collaborating with a NASIC customer that could use the product immediately and saw enough value to provide support and funding for further development. The second was participation by a company with the vision that a new type of data, hyperspectral imagery, would require a new type of cognitively-grounded visual display.

"The Airman Systems Directorate motto is 'there are no-unmanned systems,' hence the need to infuse human factors and psychology into display and system development," Warren said.

THE IMPACT OF SBIR/STTR

By participating in the Air Force SBIR/STTR Program, Etegent Technologies had the opportunity for extensive collaboration with analysts, subject matter experts and support teams to identify the real roadblocks within analytical processes at NASIC. This enabled the company to better understand and characterize NASIC's challenges, then apply its engineering and analytical expertise to develop the NTellusRV tool.

Officials from Etegent Technologies say the tool can be widely applied to different types of data, so there is a large potential for it to be deployed within other NASIC flights as well as other intelligence organizations. The company is pursuing opportunities to further develop and commercialize the technology, a critical benchmark for an Air Force SBIR/STTR project.

*Provides better intelligence for
addressing potential threats*



Metis Design Corp.
BOSTON, MASSACHUSETTS

SBIR-BACKED AIRCRAFT HEALTH MONITORING TECHNOLOGY POISED FOR WIDESPREAD USE

One of the world's largest aerospace companies is looking to revolutionize the industry with new technology developed by a small business in partnership with the Air Force and Navy.

UTC Aerospace Systems, a unit of United Technologies Corp., recently signed an agreement to license the MD7-Pro digital structural health monitoring system from Boston, Massachusetts-based Metis Design Corp. This newer sensing technology offers on-demand structural health data collection and analysis for aircraft components and systems. When integrated with the UTC Aerospace Systems' Pulse Health Monitor, the MD7-Pro will provide an accurate and timely assessment of aircraft component life expectancy, significantly reducing the maintenance hours spent conducting periodic manual inspections.

Having this visibility into an aircraft's health will improve logistics efficiency through better planning of maintenance actions; offer better scheduling of spare parts to their point of use; and result in higher rates of aircraft readiness.

Metis developed hardware for the MD7-Pro with support from the Air Force SBIR/STTR Program and guidance from the Air Force Research Laboratory. Naval Sea Systems Command also supported development of the Metis system software, including its damage detection and quantification algorithm features.

UTC Aerospace Systems secured an exclusive license to the MD7 Pro, positioning Metis for growth as the capability is adopted by military and commercial customers. For Metis, the license will provide funding for many years to come, which can be used to improve the technology and pursue research in other areas, such as multifunction materials.

"Of most importance, however, it gives us real credibility," said Dr. Seth Kessler, president and CEO of Metis. "A technology we invented and developed from scratch is now going to be commercially produced and used in programs of record, which will help us secure future projects and funding."

While the Air Force and Navy have been supporting this effort for years, their more recent investments to transition the technology to programs of record helped attract the interest of UTC Aerospace Systems, Kessler added.

The technology was acquired by a prime contractor and could end up serving many aircraft programs

FUELING THE **ECONOMY**

A technology developed by a small business - under the Air Force SBIR Program and in partnership with the Navy - is expected to help significantly reduce the maintenance hours spent conducting periodic manual inspections on aircraft, like the one happening here. (Air Force photo)



UTC Aerospace Systems is enhancing the MD7-Pro system to enable aircraft structure checks in less than five minutes, thereby reducing manual inspection time and cost while maximizing fleet availability. Kevin Hawko, Vehicle Health Business Development Manager for UTC Aerospace Systems, said the new system will be capable of identifying crack size and location, loose fasteners and corrosion. The fully integrated system will provide high quality data through digitizing sensor signals at the point of measurement.

BEHIND THE TECHNOLOGY

Versatility is one of the keys to MD7-Pro digital structural health monitoring system, as it can be integrated into new aircraft designs or retrofitted into existing aircraft. The system allows repeatable, highly accurate evaluation of aircraft structural health. The structural sonar can be applied to composite or metallic structures, find new damage, track the growth of existing damage or be applied as part of a bonded repair to check effectiveness in crack arrest.

During the early stages of the Air Force SBIR/STTR project, Metis focused on the design of sensor hardware by making use of infrastructure distributed throughout an aircraft. Next, the company worked on fabrication and testing of a prototype.

For the system to be practical, it had to be able to acquire data at very high sampling rates and be networkable over large distances while still being compact.

“Those were the biggest hurdles, fitting the high performance in such a small and lightweight package, and getting many of them to network without adding a lot of cable weight,” Kessler said.

TRANSITION TO A PROGRAM OF RECORD IN PROGRESS

In addition to its commercial potential, the Metis technology behind MD7-Pro is being transitioned to the C-5 program through cooperation between the Air Force Sustainment Center and Air Force Life Cycle Management Center.

During this process - with funding from the Air Force SBIR/STTR Commercialization Readiness Program - Metis is working to mature, integrate and test the structural health monitoring system on the C-5. Those tasks will focus on sensor placement optimization and the algorithm calibration for these locations; a probability of detection assessment; an airworthiness assessment; and demonstration of the integrated system.

Since the engineering budgets of most program offices are limited, technologies like this rarely get far out of the gate.

“The biggest benefit of the SBIR program is provide funds and be a champion for new technologies that otherwise would not be investigated, researched or funded by the program offices because of higher priority projects,” said David Wilkinson, C-5 ASIP manager.

COATING DEVELOPED FOR MILITARY USE SHOWS COMMERCIAL PROMISE

A Virginia-based company is better positioned for long-term growth because of its work on a coating technology for the Department of Defense.

Luna Innovations has filed for patents for the general coating formulation and signed a licensing agreement with partner UltraTech International for production and marketing. Under the trade name Gentoo, the coating is providing royalties to Luna while being evaluated for wider global use by dozens of companies in various industries such as glass, automotive and biomedical.

Originally developed for pilots who faced a hazard with water pooling on aircraft canopies and windshields, the coating is designed to quickly shed water off transparent surfaces for improved visibility during inclement weather.

Through the Air Force SBIR/STTR Program, Luna has been part of an ongoing development program at Hill Air Force Base in Utah for F-16 canopy coatings and currently is going through qualification testing in collaboration with the canopy manufacturer.

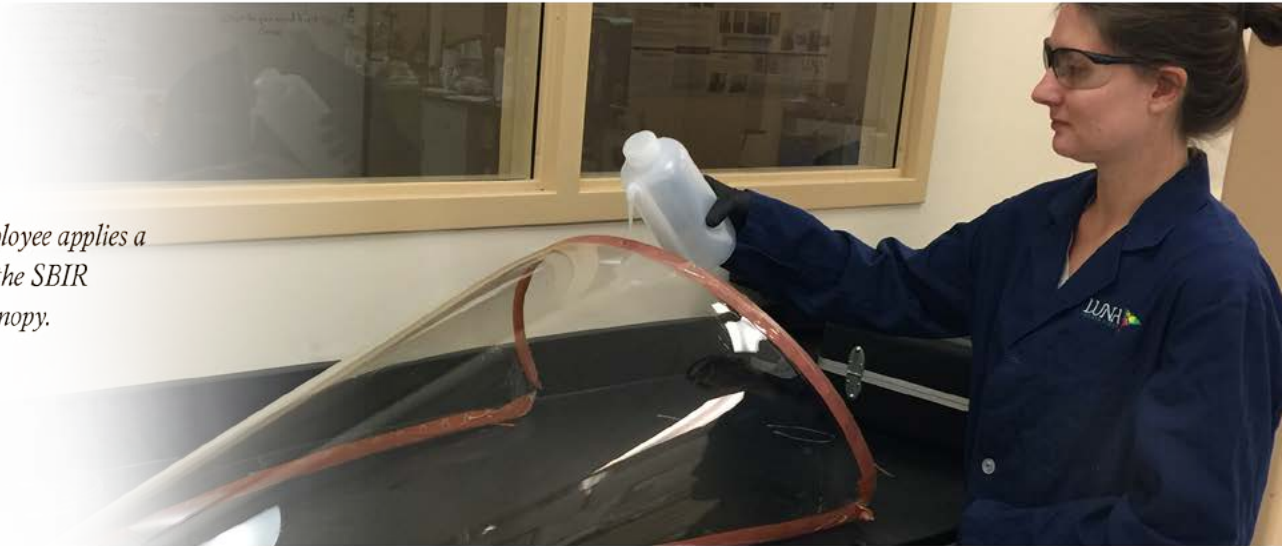
Initial SBIR funding through the Navy was used to develop a formulation that combines fluid repellency and abrasion resistance. Follow-on funding through the Air Force SBIR/STTR Commercialization Readiness Program is allowing Luna's team to optimize the formulation for improved adhesion during severe environmental conditions on jet aircraft, such as sand abrasion and impact damage from rain erosion at more than 500 knots.

An additional benefit that may emerge from this SBIR effort is a new process to estimate performance on a rain erosion test, according to Tim Lucas, a mechanical engineer for the 416th Supply Chain Management Squadron, which supports the F-16.

The ability to perform rain erosion testing – required to certify a coating like Luna's – is limited by the availability of an expensive testing facility. Lucas said Luna is working toward a way that readily-available equipment could be used to provide an estimate, which would allow future coating developers to determine if they are heading in the right direction before going through the trouble of scheduling an official test at one of those facilities.

FUELING THE **ECONOMY**

A Luna Innovations employee applies a coating developed under the SBIR program to an aircraft canopy.
(Courtesy photo)



BEHIND THE TECHNOLOGY

There have been many academic and commercial efforts focused on the development of coatings – known as hydrophobic and superhydrophobic – that quickly shed water off surfaces. A large number of those have demonstrated the primary goal of achieving water shedding properties, but lacked durability or have been too difficult or too expensive to apply.

Luna's chemists used their expertise in polymeric structures to modify a sol-gel (silica-based polymer) to incorporate very hydrophobic structures. This provides for the hydrophobic nature of the coating's surface which causes water to bead and roll off.

Luna's rain-repellent coating is a simple treatment solution that can be applied by the manufacturer to polycarbonate or acrylic-based canopies, polyurethane, metals and glass. This thin, hard coating is more than 99 percent transparent across the visible spectrum with less than 0.5 percent haze.

SBIR SUPPORT WAS CRITICAL

"Selling the product commercially provided (Luna with) additional funding to work in parallel to support the SBIR programs, thus providing the technology to the government economically and mitigating the risk that is inherent in a new product development," said Bryan Koene, director of advanced materials for Luna. "We have also transitioned the coating to other government agencies by demonstrating improved corrosion resistance on metal substrates."

Luna currently has five separate SBIR programs focused on the development of the base chemistry of this coating for different Department of Defense applications.

*Dozens of companies across various industries
are evaluating the coating for possible uses*

RADAR SHIELD ADVANCEMENTS HELP SMALL BUSINESS ATTRACT COMMERCIALIZATION PARTNER

New technology that attacks the long-term maintenance problems of ground-based radar structures – and their associated costs – is translating to commercial success for a California-based small business.

Ebert Composites Corp., with support from the Air Force SBIR/STTR Program, developed a method to improve the construction of protective shields for radar antennas that attracted a global business partner in the process.

Also known as radomes, existing shields present several significant problems. They delaminate – in essence the layers of material peel apart – and require re-painting to continue to repel water. Additionally, the current crop of radomes are at a high risk of collapse from snow accumulation. Those maintenance challenges combine to cost the Air Force and other federal organizations millions of dollars per year.

Based on its early success in addressing the delamination issue under the SBIR program, Ebert Composites was able to secure a Rapid Innovation Fund award to install a next generation radome at an Air National Guard facility in Connecticut. Saint-Gobain Performance Plastics assisted on that project and was so impressed with the result, it licensed the non-delaminating technology from Ebert Composites.

“It’s quite an enhancement to our credibility,” said David Johnson, chairman and CEO of Ebert Composites, about the licensing agreement. “The SBIR program has been very good for us in that we can do development work and own the technology. It’s really put our name on the map with the composites industry.”

BEHIND THE TECHNOLOGY

Ebert Composites solved the delaminating issue by first developing robotic technology for inserting three-dimensional fiber through sandwich structures in thermosets. The Air Force SBIR/STTR project allowed the company to adapt this technology to the thermoplastic composites used to build radomes. Next, a permanent water repellent barrier was created by using a fluoropolymer coated fabric made by Saint-Gobain.

Ebert Composites’ solution provides the structural strength for the radome while the coated fabric made by Saint-Gobain repels water, which could otherwise cause serious degradation to radar signals.

FUELING THE **ECONOMY**

*A radome undergoing a test fit
outside of Ebert Composites
facility in California.
(Courtesy photo)*



*Licensed the technology to a
global company, which invested
millions of dollars for production*

Since the licensing agreement was signed, Saint-Gobain has invested approximately \$5 million to prepare its existing Seattle-area facility and purchase equipment from Ebert Composites to manufacture the sandwich panels. That facility, which has been making radomes for aircraft, recently began production of radomes for ground-based systems.

"We've been looking for years for an advancement in materials technology that wasn't cost prohibitive," said Chuck Hobbs, business manager for fabricated systems at Saint-Gobain Performance Plastics. "Until this (new development), sandwich radomes hadn't changed much in the last 50 years or so."

While the cost to make and install the new generation of radomes is comparable to that of legacy radomes, the average savings for maintaining each newer structure could easily top the six-figure mark during its lifecycle, according to Hobbs.

Saint-Gobain is pressing forward to commercialize the technology, which includes discussions with the Air Force and other organizations that have a need to replace deteriorating radomes.

POTENTIAL FOR MASSIVE SAVINGS

An analysis from the early 2000s showed the Air Force could save more than \$130 million over a 30-year period by mitigating the most pressing radome maintenance issues, according to David Lindquist, lead engineer for the tactical shelters, radomes and towers division of the Air Force Life Cycle Management Center.

That prompted Air Force officials to approach industry for a better solution. However, radome manufacturers showed little interest in pursuing an upgrade to the technology at the time.

"Radomes are high maintenance, especially when we have to go into remote areas like Alaska," Lindquist said. "We knew we had to raise the bar because we were getting killed on maintenance costs."

The Air Force SBIR/STTR partnership with Ebert Composites appears to have hit the target. Barring minor issues, the new generation of radomes ready for the field are expected to be maintenance free for decades.

SOLUTION TO MICROCHIP OVERHEATING IN SPACE APPLICATIONS DRIVES COMMERCIAL SUCCESS

A new microchip cooling technology that paves the way for higher-performance electronics on spacecraft is spurring growth at a Missouri-based small business.

With support from the Air Force SBIR/STTR Program, ThermAvant Technologies successfully demonstrated advanced thermal management solutions for spacecraft electronics based on an emerging, but mostly untapped technology. Since its initial research project for the Air Force, the company has entered dozens of agreements to supply the solution for aerospace and defense applications.

These types of transitions – supported by the Air Force SBIR/STTR Commercialization Readiness Program – help bring down the cost of the technology while making it more readily available to both military and civilian customers.

According to ThermAvant officials, this project allowed the company to create more than a dozen jobs and attract outside investment. ThermAvant has also applied for multiple patents that directly and indirectly resulted from work on Air Force SBIR/STTR efforts, positioning it to be a long-term, stable supplier of thermal management products

The company has entered dozens of agreements to supply the solution

BEHIND THE TECHNOLOGY

Improved heat transfer technologies are important because as microchips' internal circuits overheat, their resistance increases and their efficiencies, outputs and lifespans decrease exponentially. This problem is becoming more of a challenge every year as the number of transistors packed into an integrated circuit grows. As microchips get smaller and more powerful, they are more susceptible to overheating.

FUELING THE **ECONOMY**

Michael Hurtman and Roger Davis of ThermAvant Technologies inspect a part at the company's Missouri facility. With support from the Air Force SBIR/STTR Program, ThermAvant has demonstrated advanced thermal management solutions for spacecraft electronics using an emerging technology. (Courtesy photo)



Electronics cooling is an issue that is particularly difficult to solve in space vehicles, which – unlike terrestrial or shipboard applications – do not have access to air- or liquid-cooled heat sinks.

To address the issue, the Air Force Research Laboratory's Space Vehicles Directorate went searching for a new class of microchip heat spreaders that were thin, lightweight and could be manufactured from a variety of materials. Another key feature would be high-thermal conductivity, so that when attached to small, high-powered microchips, the waste heat generated would be efficiently dissipated across the spreader's larger surface area without creating hot spots at the microchip interface.

ThermAvant chose to build heat spreaders based on the promising, but rarely applied, oscillating heat pipe technology, also known as OHP.

OHPs are built from a base material with internal serpentine micro-channels filled and sealed with a saturated working fluid. They operate by converting the device's thermal energy – waste heat – into the internal working fluid's kinetic energy. Expansion and contraction forces move, or oscillate, the fluid to-and-from hot and cool channel areas. And when the fluid flows, so does the heat. Using the fluid's two-phase heat transfer mechanism, OHPs can have effective thermal conductivities more than 100-times greater than its base materials.

AIR FORCE SUPPORT WAS CRITICAL

According to Joe Boswell, co-founder and CEO of ThermAvant, funding from the Air Force SBIR/STTR Program supported the company's advancement of OHP technology in four critical areas: Predictive modeling and theoretical investigation of the OHP's complex heat transfer mechanisms; multiple rounds of empirical prototyping and testing; manufacturing, processing and quality-assurance advancements to meet the reliability requirements of real-world spacecraft programs; and gathering of a multi-disciplinary research team that included experts from ThermAvant, the Air Force, the University of Missouri and a large defense contractor.

ThermAvant is now supplying OHPs and micro-channel cooling solutions for a wide range of platforms, from aerospace electronics to data center enclosures and energy storage systems. Since the initial Air Force SBIR/STTR award, the company also has engaged in more than a dozen government-led research projects focused on removing existing thermal solutions to be replaced by OHP technology.



PC Krause and Associates Inc.
WEST LAFAYETTE, INDIANA

INDIANA COMPANY GIVES LIFT TO AIRCRAFT POWER AND PROPULSION SYSTEMS

Newly improved motor control technology could provide a significant boost to the performance of remotely piloted aircraft.

With support from the Air Force SBIR/STTR Program, Indiana-based PC Krause and Associates Inc. has developed a system that may be capable of meeting a wide range of small aircraft electrical power and propulsion system needs.

The company – also known as PCKA – was aiming for its new modular motor drive system to fill the gap between existing commercial equipment and custom solutions at a cost that is viable for most RPA platforms. PCKA touts that its new motor drives offer reduced weight and improved efficiency, compared to current electronic speed controllers, as well as the capability to implement sophisticated control and protection software.

BEHIND THE TECHNOLOGY

RPA platform optimization and system integration often require a high degree of customization in both the motor controller software and hardware. However, development programs often lack the appropriate technical expertise and/or funding required to develop a custom solution for each aircraft design. As a result, many platforms use commercial off-the-shelf equipment that is often limited in performance or larger than necessary.

Through its work with RPA developers, the Air Force recognized a need for a fully configurable modular motor control solution that provides power scalability with appropriate reliability, ruggedness and weight/volume optimization not currently available in the marketplace.

Under the Air Force SBIR/STTR Program, PCKA created a modular motor control solution that includes a main control module, a range of peripheral expansion modules and a range of interchangeable power stage modules.

A key feature of the technology is its open hardware and software architecture, which enables users with minimal expertise to meet typical platform needs while providing advanced users the capability to rapidly customize portions of the system to meet sophisticated performance and control objectives. This also allows RPA developers to focus their resources on expanding mission systems and platform capabilities instead of motor controller design and optimization.

DEMONSTRATED RELEVANCE

*PCKA personnel performing
electronic speed controller
module inspection.
(Courtesy photo)*



EARLY APPEAL

PCKA partnered with multiple RPA developers and the Air Force Research Laboratory's Aerospace Systems Directorate to clearly define what was needed to create a successful modular motor drive ecosystem. This provided the company an opportunity to develop the necessary base software and prototype hardware to demonstrate the advantages of the system to initial customers, which led to the commercial interest even before the next development phase in the SBIR program.

As a result of the early-stage hardware demonstration, PCKA delivered production controllers for Lockheed Martin's Maritime Canister Launch Small Unmanned Air System, an adaptation of the Vector Hawk platform. These first-run controllers have completed system integration and initial flight testing with further development and testing ongoing.

Additionally, PCKA is working with AFRL and Georgia-based Area-I to integrate and flight test PCKA's developed

*A prime contractor has already
taken an interest in this
early-stage RPA technology*

modular motor drive in Area-I's Prototype-Technology Evaluation Research Aircraft platform.

PCKA also has been selected for additional SBIR funding to expand the range of modules available in the modular motor drive ecosystem; refine the base control software to further improve performance and ease of use; and explore advanced control algorithms for both RPA and other applications.

A BETTER WAY TO FIND THE BAD GUYS

The Department of Defense is partnering with small business to develop a powerful new tool for tracking down adversaries.

Virginia-based Applied Signals Intelligence - with support from multiple services, including the Air Force SBIR/STTR Program - developed a direction finder for pinpointing enemy transmissions that is compact enough to fit on a small remotely piloted aircraft.

Until now, integrating a tool this complex into small RPAs wasn't an option.

Initially an Army SBIR topic, the technology went through additional development under the Navy and Air Force SBIR programs.

"The warfighter is the ultimate beneficiary and our tight coordination across the tri-services maximizes the value of the taxpayers' dollars," said Matthew Shuman, an electrical engineer at the RF Systems Branch of Air Force Research Laboratory's Sensors Directorate.

BEHIND THE TECHNOLOGY

Adversaries use a wide range of widely available HF, VHF and UHF (High Frequency/Very High Frequency/Ultra High Frequency) push-to-talk radios for wireless command, control and communications. To counter those threats, intelligence operators use radios to find transmitters in the RF spectrum and direction finding equipment to get a fix on their positions.

High-frequency direction-finding technology has been around for years. However, these systems have traditionally been very large – as the aperture size was proportional to the wavelength of interest - and required a large platform to deploy.

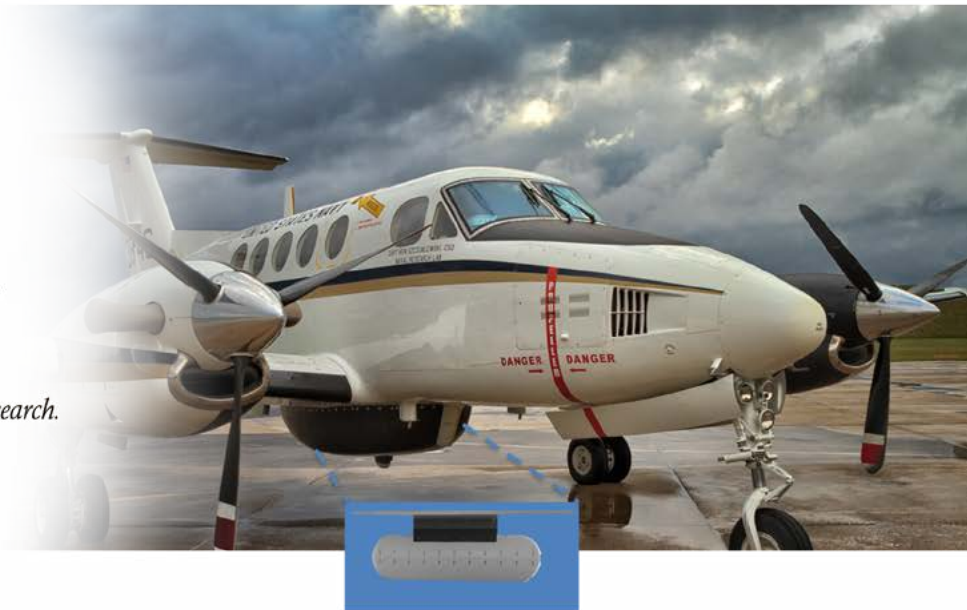
Under the Air Force SBIR project, Applied Signals Intelligence addressed a major challenge of antenna size constraints and accuracy performance tradeoffs. This involved using aperture sizes that are a small fraction of the wavelengths.

The company first developed a ground-based, 2D direction finding system for the Army, which operates on electromagnetic waves propagating along the ground from vertical-oriented antennas. This works because the Earth shorts out other fields, however that same system can't be used from the air as electromagnetic waves propagate in all directions and there is no ground to short them out.

To solve the issue, Applied Signals Intelligence quantified the airborne characteristics of its 2D system to create a 3D finding system – dubbed "precision DF" – for the Air Force. The 3D system operates on waves propagating in all directions and from all antenna orientations.

DEMONSTRATED RELEVANCE

A Navy RC-12 King Air with an Applied Signals Intelligence payload attached. This version uses the direction finder functionality developed under the Air Force SBIR/STTR Program to take unique spectrum measurements for the Office of Naval Research.
(Courtesy photo)



The company's precision DF technology has already been tested on a small Navy plane and is in the process of being integrated into a small RPA by the Navy.

A WIDER LONG-TERM IMPACT

This advancement has the potential to greatly impact the Air Force intelligence, surveillance and reconnaissance mission, where there have been multiple capability gaps in the area of HF/VHF/UHF direction finding.

"Not only does this directly support our mission needs for direction finding, but for other mission requirements, where direction finding is a supporting technology that enables other advancement," Shuman said. "A prime example of this is spectrum monitoring."

The technology will continued to be developed with

support from the Air Force SBIR/STTR Commercialization Readiness Program and a private sector company has already agreed to purchase several systems during the next few years to integrate and supply them to the military.

"SBIR funding allowed a small company to tackle this issue when larger and well established companies thought that this technology would never be possible," said Martin Rofheart, CEO of Applied Signals Intelligence.

A way to pinpoint enemy transmissions that is compact enough to fit on an RPA

ENVISIONING A GIANT LEAP IN AVOIDING MID-AIR COLLISIONS

A California-based small business is filling a critical need for improved collision avoidance technology aboard unmanned aircraft.

UtopiaCompression Corp. – with support from the Air Force SBIR/STTR Program and the Defense Advanced Research Projects Agency – has developed and recently tested a sense-and-avoid capability that uses passive equipment and does not require the host unmanned aircraft system to maneuver. That combination allows other aircraft as small as a Cessna 172 to be detected and tracked at a distance of up to three nautical miles, which is a significant advancement compared to existing technology.

Because of its success, UtopiaCompression has attracted additional support from the Air Force SBIR/STTR Commercialization Readiness Program as well as DARPA, which is managing the current project. Company officials are aiming for the advancement to have a transformational impact on the process of integrating UAS into the Federal Aviation Administration's NextGen, the comprehensive overhaul of the National Airspace System, by removing a major technological barrier.

Additionally, this technology could eventually improve the situational awareness of general aviation pilots if it can be sufficiently miniaturized for installation in the cockpit.

"This sense-and-avoid system has the potential to enable a wide range of manned and unmanned systems to safely integrate into an increasingly populated and complex airspace," said Dr. Dan Patt, a program manager in

*Elevates RPA sense-and-avoid
capabilities to a whole new level*

DARPA's Tactical Technology Office. "Working with the Air Force rallies joint resources around an important problem and brings Air Force expertise to bear on these emerging technologies."

BEHIND THE TECHNOLOGY

Passive electro-optical/infrared sensors are attractive for collision avoidance on all classes of UAS – also known as remotely piloted aircraft, or RPA – because of their low cost, size, weight and power requirements. However, those passive sensors traditionally suffer from the drawbacks of high false alarm rates and

DEMONSTRATED RELEVANCE

Scientists from UtopiaCompression Corp. work on a new sense-and-avoid capability that could fill a critical technology gap. (Courtesy photo).



an inability to determine a range to the target without maneuvering.

The Air Force SBIR requirement was for UtopiaCompression to develop a practical and effective approach to accurately estimate the range from an RPA to a relatively small aircraft up to a few nautical miles away with passive sensors and without requiring deliberate action.

An analytically proven, practical approach for maneuverless monocular, passive range estimation – which represents the first practical solution to a decades-old problem – forms the basis for this innovative technology. The company's system incorporates a camera and a lens system, along with a Global Positioning System/inertial navigation system unit, all of which provides imagery and aircraft attitude data for detection and tracking.

The information is fed into a proprietary algorithm to estimate the state of an intruder. If a mid-air collision is predicted, an alert is triggered to give the RPA time to autonomously avoid a potential disaster.

UtopiaCompression's system filters out false positives by removing tracks that do not match an intruding aircraft's profile, such as those made by clouds or ground clutter. In flight demonstrations, the company reduced the number of false tracks by more than 50 percent compared to a baseline system that does not use passive ranging technology.

BIG POTENTIAL BENEFITS

Earlier this year, the joint DARPA/Air Force effort completed the first successful flight tests of a shoebox-sized, plug-and-play system designed to enable manned and unmanned aircraft to automatically detect nearby aircraft and avoid mid-air collisions.

Such a capability would be a game changer for small RPAs that cannot carry bulky and power-intensive sensors, such as on-board radar. Even for large RPAs that can carry radar, having an additional ranging and collision-detection capability would provide a safeguard against radar defects.

A truly passive sense-and-avoid capability could also enable operations where radio frequency emissions can be detrimental.

Future planned research aims to shrink the system size and mature key aspects, such as detecting aircraft below the horizon in poor light conditions.

UtopiaCompression currently has several sense-and-avoid programs encompassing novel payload design, embedded prototype development and modeling and simulation efforts. According to Dr. Joseph Yadegar, president of UtopiaCompression, the company is working with prime contractors and government agencies to transition the technology.

Chip Design Systems LLC
HOCKESSIN, DELAWARE

NEW TESTING TECHNOLOGY REMOVES BARRIER TO EXPLOITING IMPROVED SMART WEAPON CAPABILITIES

The next generation of smart weapons is a step closer to the warfighters' arsenal because of a partnership between a Delaware-based small business and the Air Force Research Laboratory.

With support from the Air Force SBIR/STTR Program, Chip Design Systems LLC and its team of experts worked with AFRL's Munitions Directorate to bridge the gap between newer smart weapon sensors and the ability to fully exploit those improved capabilities.

Smart weapons with Infrared imaging sensors are known for their accuracy and can provide big tactical advantages, but the path to their deployment requires extensive validation testing on the ground.

BEHIND THE TECHNOLOGY

Smart weapons use infrared imaging seekers to detect and hit targets. While large amounts of money are spent developing this class of sensors, the industry has devoted much less funding toward test technologies.

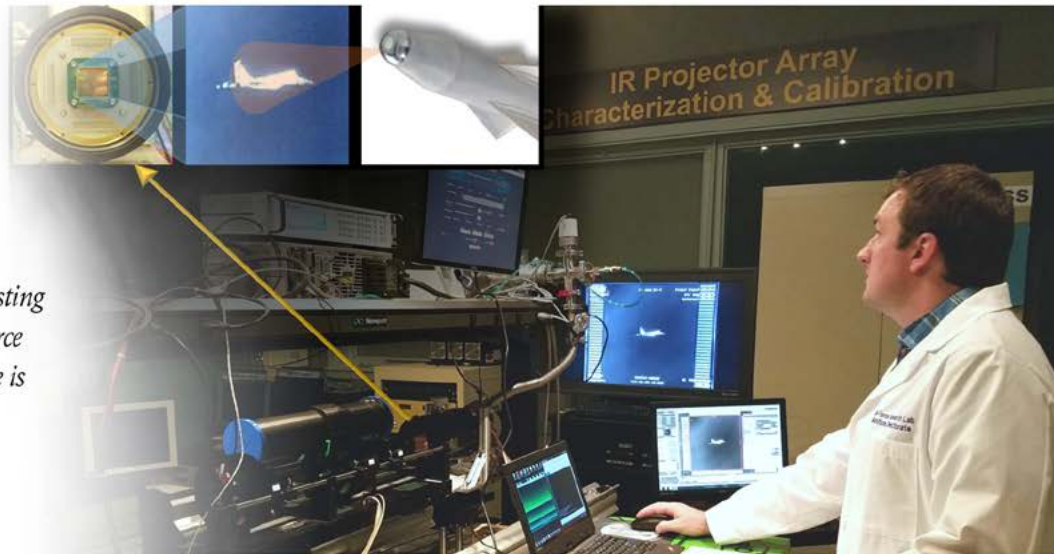
In recent years, the infrared scene projectors used for testing infrared imaging seekers have seen only modest improvements in brightness, spatial resolution and frame rate. Meanwhile, those sensors have improved at a much faster rate, so the ability to test them has been severely limited.

The Night Glow Short Wave Infrared LED Image Projector Development – also known as NSLEDS – was intended to demonstrate an infrared scene projector that used the newest micro-infrared light-emitting diode array technology. This concept is similar to the visible LEDs in today's light bulbs, but producing infrared light images on a high- resolution, micron-size scale.

By offering at least twice the frame rate and higher brightness, with the same image resolution of current micro-resistor based arrays, NSLEDS allows infrared scene projectors to keep up with newer imaging performance. As a result, the Air Force now has a means to test next-generation smart weapons

Advanced weapons will be able to detect faster, smaller moving targets

DEMONSTRATED RELEVANCE



A scientist prepares to operate a new testing technology developed under the Air Force SBIR/STTR Program. This prototype is expected to help pave the way for next-generation smart weapons. (Air Force photo)

that are able to detect smaller, faster moving targets in increasingly complex backgrounds.

Officials from Chip Design Systems say the Air Force SBIR/STTR Program was critical to building and integrating the system. Among the critical components funded were micro-infrared LED arrays that generate the infrared light; read-in-integrated circuits that allow the addressing and intensity modulation of each pixel; and the electronics and packaging necessary to demonstrate performance capability.

A TEAM EFFORT FUELED PROGRESS

Chip Design Systems handled the tasks of read-in-integrated circuit design, package design and thermal modeling, while leading a team of experts including:

- The University of Iowa and Firefly Photonics - micro-infrared LED fabrication;
- ON Semiconductor - CMOS chip fabrication;
- Teledyne Scientific - hybridization; and
- The University of Delaware - system and CSE design

In early 2017, the NSLEDS project delivered a first prototype to Eglin Air Force Base for further technical evaluation and has already logged several hundred hours of operation.

This prototype paved the way for Chip Design Systems to receive a contract to create an even higher resolution device for smart weapon testing by the Air Force. By applying lessons learned and technology developed under NSLEDS, the company is now in the process of building an infrared LED scene projector with four times the resolution at a significantly reduced risk.

BACKGROUND IN ACADEMIC RESEARCH

The innovation brought to life during NSLEDS is a solid example of academic research being transitioned to a small business to meet Department of Defense needs.

The roots of Chip Design Systems can be traced to research started more than a decade ago at the University of Delaware. There is still a close relationship between the two and a key to this latest advancement was intellectual property licensed to Chip Design Systems by the university.

NEW TECHNOLOGY SHOWS PROMISE FOR GROUND OPS TO SIDESTEP GPS JAMMING THREATS

Ground forces may soon be getting a new tool to find their way around hostile territory.

With support from the Air Force SBIR/STTR Program, Virginia-based Echo Ridge LLC is developing a process to overcome GPS-contested environments by using radio frequency signals as a source of positioning information. The solution is designed to fit in a small package that can be carried by ground operators.

GPS has revolutionized warfighting by providing a ubiquitous, all-weather, absolute positioning, navigation, and timing capability that is unrivaled. However, many Department of Defense platforms have become overly dependent on GPS, making the signal a prime target for the enemy.

Under a special type of SBIR/STTR contract – known as a Direct-to-Phase II award, offered by the Air Force Research Laboratory Center for Rapid Innovation – Echo Ridge is working with the AFRL Sensors Directorate to solve this pressing issue.

BEHIND THE TECHNOLOGY

Adversaries use GPS jammers to disrupt allied operations as well as to protect themselves from attack by aircraft-launched precision weapons. These jammers deny access to the GPS signal for our ground forces in the region, making it difficult to navigate.

Echo Ridge developed and applied its technology to build a hand-held device that can provide navigation information to ground forces, according to Mark Smearcheck, an electronics engineer with the AFRL Sensors Directorate. The company worked to provide a complementary, backup source of positioning, navigation, and timing by creating an algorithm to aggregate signals of opportunity from various radio frequency sources. The algorithm is used to determine a position based on the time difference of arrival of those signals, which do not operate on the same frequency as GPS.

By receiving and processing various radio frequency sources not designed for navigation purposes, the new system can pinpoint a user's location without relying on GPS. The device connects to a smart phone running the

DEMONSTRATED RELEVANCE

Personnel from the 724th Special Tactics Group at Ft Bragg recently tested new navigation technology developed by Echo Ridge, a small business, in partnership with the AFRL Sensors Directorate. (Air Force photo)

Insert: The hand-held prototype developed by Echo Ridge. (Courtesy photo)



Android Tactical Assault Kit, a device typically carried by Air Force ground operators, to display the navigation solution on a map.

With the process developed by Echo Ridge, the errors do not accumulate over time, as they might with a

Handheld device pinpoints a user's location without relying on GPS

traditional dead-reckoning approach, so a valid position can be produced indefinitely. Additionally, multiple signal sources are used simultaneously, which provides redundancy and increased immunity to adversarial attack.

"We're measuring signals that have known or discovered geographical locations," said John Carlson, chief technical officer at Echo Ridge. "Because we're able to precisely measure those signals, we can accurately estimate position without error growth over time or distance traveled."

SPARKING INTEREST FROM OTHER FEDERAL AGENCIES

Funding provided by the Air Force SBIR/STTR Program allowed Echo Ridge to turn a laboratory concept into a prototype device in a small, low-power package.

Echo Ridge and the AFRL Sensors Directorate recently completed a field test and demonstration at Fort Bragg in North Carolina. The company is working to improve its usability and address ruggedness issues that would position the device for wider use in the field. While still in the development phase for the Air Force, this technology has sparked interest from other potential federal customers.

"The Air Force SBIR/STTR Program really helps take some of the risk out of developing technology like this," Carlson said. "The funding was absolutely critical to our efforts."

NEW INSTRUMENT SHOWS BIG POTENTIAL TO HELP MISSION PLANNERS

An innovative scanning technology developed by a Colorado-based small business may eventually save lives and boost the success rate of military missions.

Funding from the Air Force SBIR/STTR Program helped Atmospheric and Space Technology Research Associates – also known as ASTRA – to create a new instrument to pinpoint atmospheric problems that impact communication and navigation signals. This compact smart-scan mirror provides near real-time detection of “bubbles” in the Earth’s upper atmosphere, which can interfere with radio signals used by the Department of Defense.

Armed with the data, military planners could avoid performing operations in areas where the irregularities are occurring.

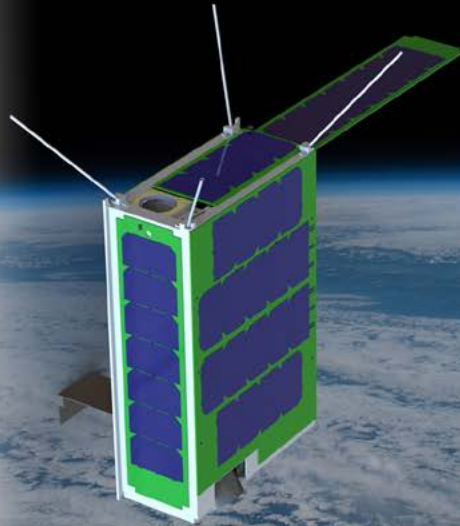
THE DOWNFALL OF EXISTING METHODS

Current technology cannot be used to predict bubbles in the ionosphere or provide real-time measurements with adequate precision. While imagers aboard Department of Defense weather satellites are available, for example, they are limited to coverage in the evening hours and only provide images at 100-minute intervals.

The goal of this Air Force SBIR project was for ASTRA to develop a smaller and more versatile instrument that can produce images of the nightside ionosphere by viewing ultraviolet light emanating from the atmospheric gases. Also known as SIPS, for Scanning Imaging Photometer System, the new instrument consisted of a UV detector and a scan mirror.

A similar concept has been flown on other satellites. However, each of those imagers was large, expensive and had a single simple scan-mirror mode, which was continuously repeated, so the signal was weak and overcome by background noise in areas of low ultraviolet intensity.

*ASTRA created a new instrument to pinpoint atmospheric problems that impact communication and navigation signals.
(Courtesy rendering)*



POTENTIAL FOR WIDESPREAD USE

One of ASTRA's advancements with this project is that SIPS is significantly smaller, lighter and cheaper than instruments flown previously, and requires only about a tenth of the power, so that it can easily be placed on small satellites called cubesats. A small group of SIPS-carrying cubesats could provide almost continuous imagery of the irregularities that cause poor UHF-based satellite communications and GPS positioning outages that can endanger lives in combat situations.

Another achievement of the project was the creation of a mirror with multiple scan modes. This allows useful measurements, even in low-signal regions of the Earth's ionosphere. The signal-to-noise ratio of SIPS is also about 10 times better than current technology, so structures in the ionosphere can be more readily identified. Additionally, the plug-n-play interfaces on SIPS trim months from the integration and test process of traditional satellite systems.

While the focus of SIPS has been on producing an instrument that can provide overhead images of the ionosphere, ASTRA officials say it also has the potential to provide other important ionospheric parameters. Those could be useful to the Air Force as well as other federal agencies for space situational awareness.

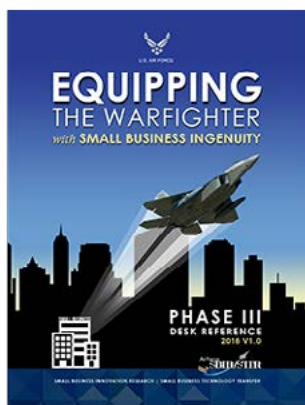
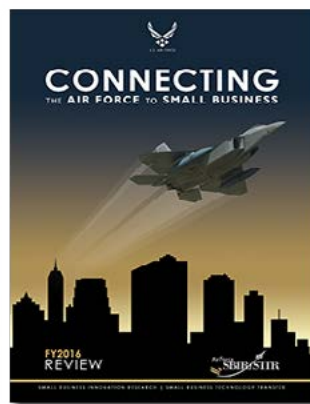
"The potential for transition into operations is enormous," said Dr. Geoff Crowley, CEO of ASTRA. "The SIPS instrument is so effective and low-cost that a few of them on small satellites would provide continuous mission-critical data on the locations where space weather effects are jeopardizing radio systems (for communication and navigation) and lives are being lost."

*A more reliable way to mitigate
danger in combat situations*

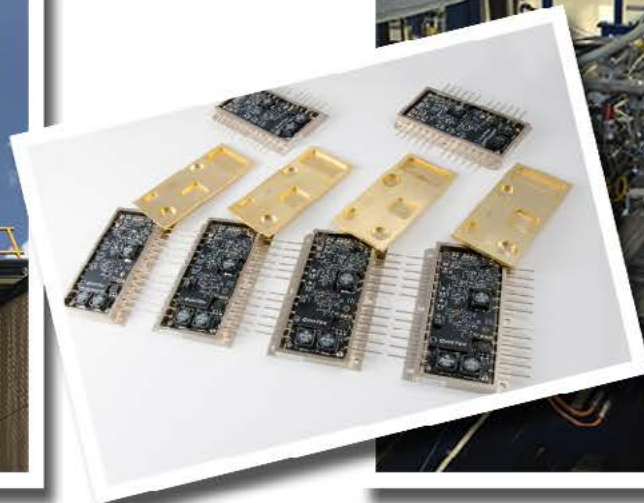
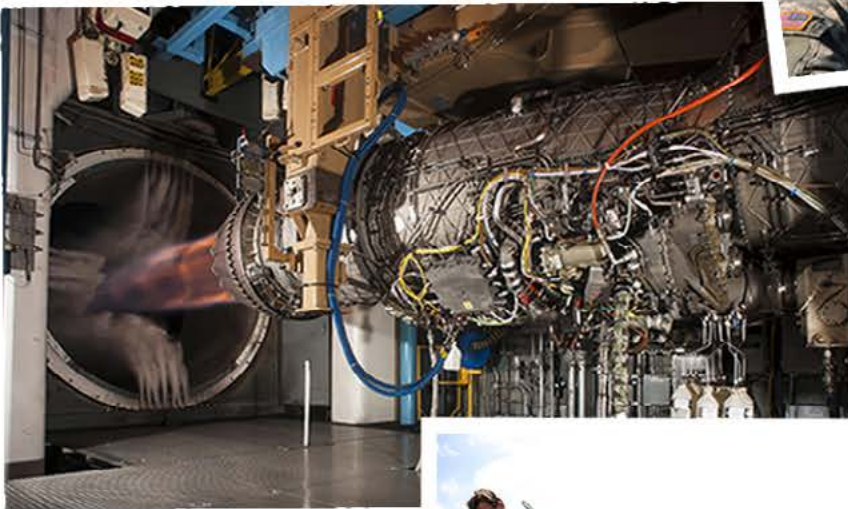
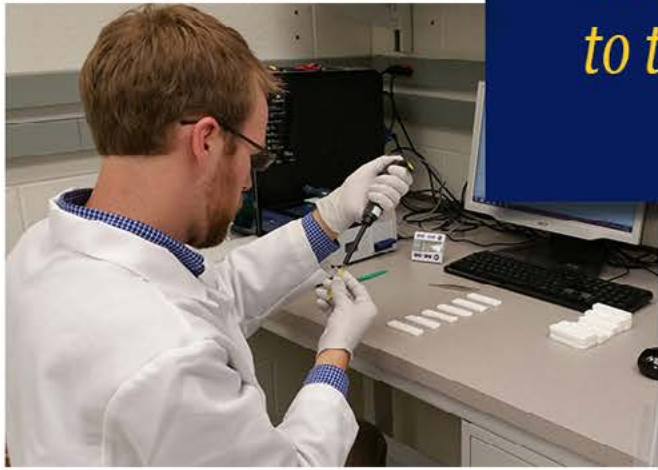
ADDITIONAL INFORMATION

In addition to our annual Achievements book, the Air Force SBIR/STTR Program Office also delivers key messages and communications through publication of a variety of additional booklets, newsletters and reference documents. Some of those publications are our annual Year in Review document, the quarterly SBIR/STTR program newsletter *Advantage*, and the Phase III Desk Reference, a guidebook that focusses on the use of SBIR/STTR technology to realize mission cost savings and technology objectives and describes SBIR/STTR inclusion in program planning and management throughout program life cycles.

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